DEQ Nutrient Work Group
Meeting 5

Achievable Technology for Municipal Wastewater Systems

September 17, 2009

HDR

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Overview

- Capabilities of Nutrient Treatment Technologies
- Translation of Numeric Nutrient Standards to Discharge Permit Limits
- Appropriate Discharge Permit Structures for Nutrients
  - Treatment process variability
  - Statistical performance characteristics
  - Seasonal averages vs. Max Month, Week and Day limits
- Example Discharge Permits for Nutrients

NUTRIENT TREATMENT TECHNOLOGY

Wastewater Nutrient Removal Treatment

- Generalized Levels of Treatment
  - -BNR Biological Nutrient Removal
    - - TP 1 mg/l, TN 10 mg/l
      - -Modify Biological Treatment Process for N and P Removal
  - -ENR Enhanced Nutrient Removal
    - -TP 0.25 to 0.5 mg/l, TN 4 to 8 mg/l
      - -Add Filters for P & Chemical
      - -Add Larger Reactors for N
  - -LOT Limit of Technology
    - -TP 0.05 to 0.25 mg/l, TN 3 to 4 mg/l
      - -Multi-stage filters for P & Chemical
      - -Larger & Multi-stage reactors for N

Numeric Nutrient Standards, Wastewater Treatment Capabilities and Limits of Wastewater Treatment Technology

Basis of Permit Compliance? Mean, Median, or Max? % Exceedance? Season? Flow?

LOT > Numeric Nutrient Stds?

Parameter	Typical Municipal Raw Wastewater, mg/l	Secondary Effluent (No Nutrient Removal), mg/l	Typical Advanced Treatment Nutrient Removal (BNR), mg/l	Enhanced Nutrient Removal (ENR), mg/l	Limits of Treatment Technology, mg/l	*Typical In-Stream Nutrient Criteria, mg/l*
Total Phosphorus	4 to 8	4 to 6	1	0.25 to 0.50	0.05 to 0.07	*0.020 to 0.050*
Total Nitrogen	25 to 35	20 to 30	10	4 to 6	3 to 4	*0.3 to 0.600*

Las Vegas, NV (TP 0.170 mg/l)

Clean Water Services, OR (TP 0.100 mg/l)

Lacy, Olympia, Tumwater Thurston Co (LOTT), WA (TIN 2 mg/l)

Coeur d'Alene, ID (TP 0.050 mg/l)

Effluent Requirements Below Limit of Technology

- Ruidoso, NM
  - Total Nitrogen
    - 1 mg/L 30 Day Average
    - 1.5 mg/L Daily Max
  - Total Phosphorus
    - 0.1 mg/L 30 Day Average
    - 0.15 mg/L Daily Max

REGION 6
1445 ROSS AVENUE
DALLAS, TEXAS 75202-2733

NPDES Permit No NM0029165

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

City of Ruidoso Downs and Village of Ruidoso WWTP
313 Cree Meadows Drive
Ruidoso, NM 88345

Post-Construction Effluent Limits – 2.6 MGD Design Flow – OUTFALL 001 Continued

EFFLUENT CHARACTERISTICS		DISCHARGE LIMITATIONS					MONITORING REQUIREMENTS	
		lbs/day, unless noted		mg/l, unless noted				
POLLUTANT	STORET CODE	30-DAY AVG	7-DAY AVG	30-DAY AVG	7-DAY AVG	DAILY MAX	MEASUREMENT FREQUENCY	SAMPLE TYPE
Flow	50050	Report MGD	Report MGD	***	***	***	Continuous	Totalizing Meter
Biochemical Oxygen Demand, 5-day	00310	651	976	30	45	N/A	1/Week	6-Hr Composite
Total Suspended Solids	00530	651	976	30	45	N/A	1/Week	6-Hr Composite
E. coli Bacteria (*1)	51040	N/A	N/A	126 (*2)	N/A	410 (*2)	1/Week	Grab
Cyanide (WAD) (*4)	00718	Report	N/A	Report	N/A	Report	Once/Quarter	24-Hr Composite
Total Nitrogen ,Ti <13°C (*5, *6, *7)	00600	<195.2	N/A	<9	N/A	< 9 (*8)	Once/2 weeks	24-Hr Composite
Total Nitrogen, Ti ≥ 13°C (*5, *6, *7)	00600	<130.1	N/A	<6	N/A	< 6 (*9)	Once/2 weeks	24-Hr Composite
Total Nitrogen (*5, *15)	00600	21.7	N/A	1	N/A	1.5	Once/Month	24-Hr Composite
Total Phosphorus (*10)	00665	2.2	N/A	0.1	N/A	0.15	Once/Month	24-Hr Composite
Total Thallium (*11)	01059	0.37	N/A	10.87 ug/l	N/A	16.30 ug/l	Once/Month	24-Hr Composite
TRC (*12)	50060	N/A	N/A	N/A	M/A	19 ug/l	Daily	Grab

NPDES Permit No. NM0029165, September 2007

Phosphorus Requirements Below the Limit of Technology

- Spokane River D.O. Dissolved Oxygen Total Maximum Daily Load (TMDL)
  - Total Phosphorus 8 ug/l (0.008 mg/L)
    - Best Treatment Technology Capable of TP ~0.050 mg/L
      -WAC 173-201A-450 Water Quality Off-set
  - CBOD 1.1 mg/L
  - Ammonia Nitrogen 0.25 mg/L

Discharge Location	Projected WWTP Effluent (mgd)[1]		---------Modeled Wasteload Allocation (mg/L)---------		
	2017	2027	NH3	TP	$CBOD_{ult}$[2]
Liberty Lake	1.41	1.51	*	0.008	1.3
Kaiser	15.4	15.4	0.100	0.008	1.3
Inland Empire Paper Company	4.1	4.1	1.000	0.008	1.1
City of Spokane WWTP	41.76	50.77	*	0.007	1.1
Spokane County (new plant)	8	8	*	0.008	1.1

Notes:
[1] Actual, not projected flows, will determine compliance with wasteload allocations in NPDES permits.
[2] NPDES permit limits will use $CBOD_5$ rather than $CBOD_{ult}$.
*Ammonia wasteload allocations for these facilities will remain constant in 2028 despite increased flows (City of Spokane and Liberty Lake Sewer and Water District) and are as follows:
April 1 - May 30: 1 mg/L ,
June 1 - Sept. 30: 0.250 mg/L,
Oct. 1 - Oct. 31: 1 mg/L

Revised TMDL Spokane River Wasteload Allocation, Washington Department of Ecology, May 2008

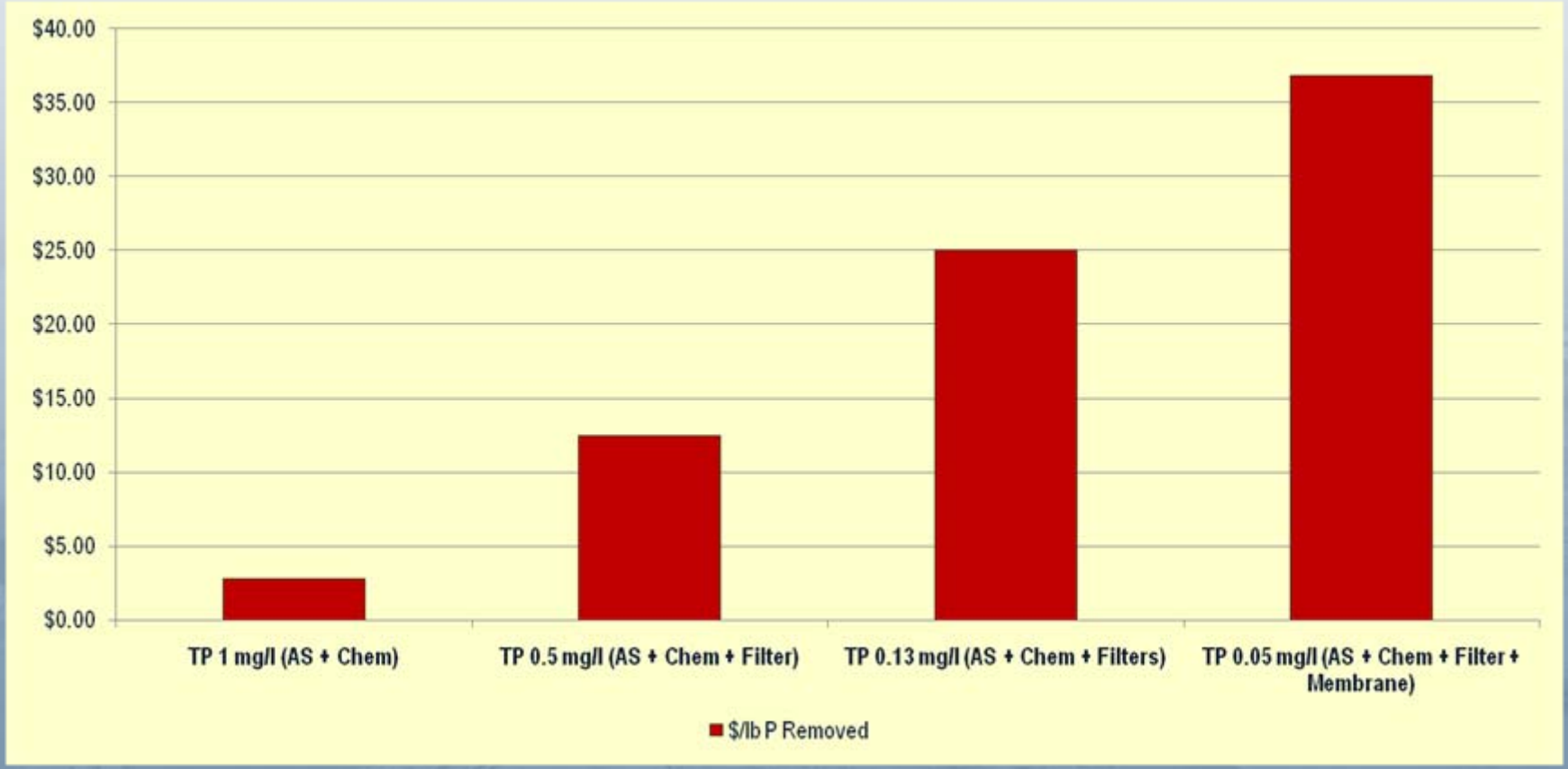
Nutrient Removal Costs Increase Dramatically As Approach Limits of Technology

- Generalized Levels of Treatment
  - -BNR Biological Nutrient Removal
    - - TP 1 mg/l, TN 10 mg/l
      - -Modify Biological Treatment Process for N and P Removal
  - -ENR Enhanced Nutrient Removal
    - -TP 0.25 to 0.5 mg/l, TN 4 to 8 mg/l
      - -Add Filters for P & Chemical
      - -Add Larger Reactors for N
  - -LOT Limit of Technology
    - -TP 0.05 to 0.25 mg/l, TN 3 to 4 mg/l
      - -Multi-stage filters for P & Chemical
      - -Larger & Multi-stage reactors for N

- BNR
  - -Economical for Most Utilities
    - - Caveat: Highly Dependent Upon the Kind of Plant You Begin With
- LOT
  - -High Costs
  - -Edge of Technology
  - -May Drive PS Dischargers Out of Rivers
  - -May Not have WQ Benefit
    - - If NPS not reduced
    - - If Development is driven away from Sewer Service Areas
- NPS Reduction May be Far More Economical
  - -Cost Effectiveness

Treatment Costs Escalate Substantially as Approach Limit of Technology

- Estimated Unit Costs for Phosphorus Removal from Base Nutrient Removal to Limit of Technology



Estimated retrofit costs at 10 mgd capacity from Jiang, et al

TRANSLATION OF NUMERIC NUTRIENT STANDARDS TO DISCHARGE PERMIT LIMITS

In-Stream Standards → Discharge Requirements

Translation of in-stream standards to effluent discharge permit limits is key to understanding facility requirements and costs

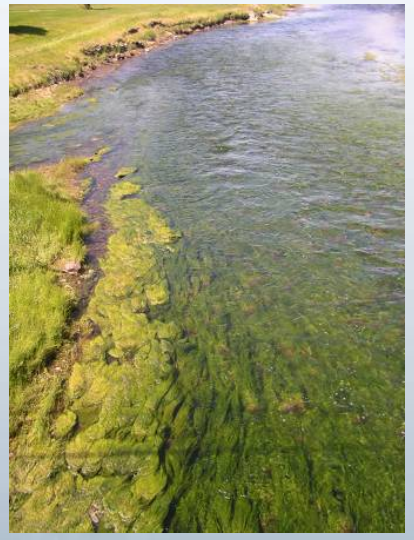


Image D 1,250 mg/m^2 Chla

Image F 150 mg/m^2 Chla

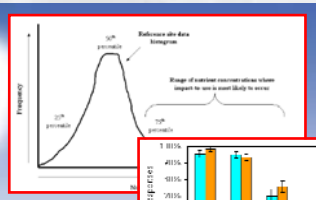
In-Stream Standards → Discharge Requirements

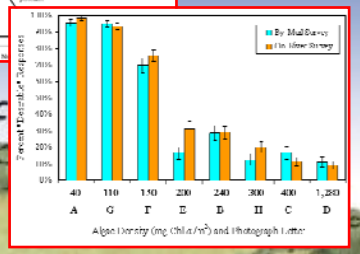
Numeric Nutrient Standard
TP 0.050 mg/l
TN 0.300 mg/l

303(d) Nutrient Impairment

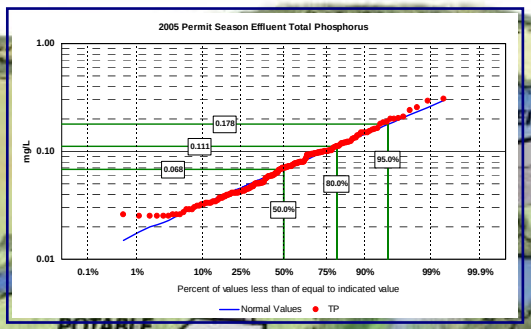
Total Maximum Daily Load (TMDL)
PS Wasteload Allocation
NPS Load Allocation
Water Quality Based Effluent Limit?

Translate to MPDES Permit Limits
Season?
Critical Flow?
Ambient > Standard?





Effluent Limits?
BNR TP 1 mg/l TN 10 mg/l
ENR TP 0.250 mg/l TN 7 mg/l
LOT TP 0.1001 mg/l TN 3 mg/l
Basis for Permit Compliance?



ATMOSPHERIC

ERSHED MANAGEMENT

INDUSTRIAL & POWER PLANT DISCHARGE

NON-POINT SOURCE RUNOFF

POTABLE WATER SUPPLY

RESTORATION

COMBINED SEWER OVERFLOW

STORM WATER RUNOFF

WASTEWATER DISCHARGE

EMERGING CONTAMINANTS

WATER REUSE

Define What Various Treatment Levels Mean and How They Will be Permitted

- DEQ Appendix I. Point Source Permitting and Compliance for Nutrients
  - Options for Establishing Point-source Effluent Limits for Nutrients
    1. Technology-based Effluent Limits
    2. Back-calculated Water Quality Based Effluent Limits
    3. Forward-calculated Water Quality Based Effluent Limits, Maximum Days with Exceedances
    4. Forward-calculated Water Quality Based Effluent Limits, Statistical Compliance Tools
    5. Cumulative Nutrient Load Standards
  - DEQ Recommends Options 2, 3, or 4

DEQ Appendix H. Statistical Considerations for Applying Montana's Numeric Nutrient Standards: Recommendations for 303(d) Listing and TMDLs

- 4.2.3 Critical Exceedance Rate
  - Clark Fork River Analysis
    - Numeric Nutrient and Benthic Algae Standards
      - TP 0.20/0.039 mg/l
      - TN 0.300 mg/l
      - Chla 150 mg/m^2
  - Found 25% Threshold Where Compliance with Algae Standard Becomes Tenuous
- DEQ Recommended Critical Exceedance Rate for Compliance with Numeric Nutrient Standards be Set at 20%

Need explanation for what this means in terms of permit compliance and how this recommendation will be converted into MPDES permits

DEQ Alternative 2: Back-calculated Water Quality Based Effluent Limits

- Back calculation to determine effluent levels based on in-stream criteria

$$C_{RP} = \frac{C_E Q_E + C_S Q_S}{Q_E + Q_S} \qquad (eq.\ 1)$$

where:

C_{RP} = receiving water concentration (RWC) after mixing, mg/*L*

C_E = effluent concentration, upper bound estimate, Appendix I, mg/*l*

C_S = RWC upstream of discharge, Appendix IIA, IIIA, mg/L

Q_S = receiving water design low flow, 7-day, 10-year low flow (20 or 23 cfs).

Q_E = effluent design flow (8.97cfs).

(*See Appendix IIB, and IIIB for actual values used in calculations for* C_{RP}, C_E, C_S)

- Show the Calculations
  - Critical Flow Assumptions
    - 7Q10 v. 30Q10 v. Other?
  - Ambient Water Quality
    - Coefficient of Variation and Extremes in Data Set
  - Effluent Water Quality
    - Assumed Coefficient of Variation
      - Variability in Low Nutrient Treatment Plants
  - Effluent Limits?
    - Monthly Average, Weekly, Daily Maximum?
- Watershed Nutrient Loadings v. Effluent Mixing Zone Calculations

DEQ Alternative 3: Forward-calculated Water Quality Based Effluent Limits, Maximum Days with Exceedances

- Use PDM to determine effluent limits corresponding to water quality standards
  - EPA's Probabilistic Distribution Model (PDM)
    - Run a range of hypothetical effluent limits until identify result applicable to standards

- Show the Calculations
  - Critical Flow Assumptions
    - 7Q10 v. 30Q10 v. Other?
  - Ambient Water Quality
    - Coefficient of Variation and Extremes in Data Set
  - Effluent Water Quality
    - Assumed Coefficient of Variation
      - Variability in Low Nutrient Treatment Plants
  - Effluent Limits?
    - Monthly Average, Weekly, Daily Maximum?

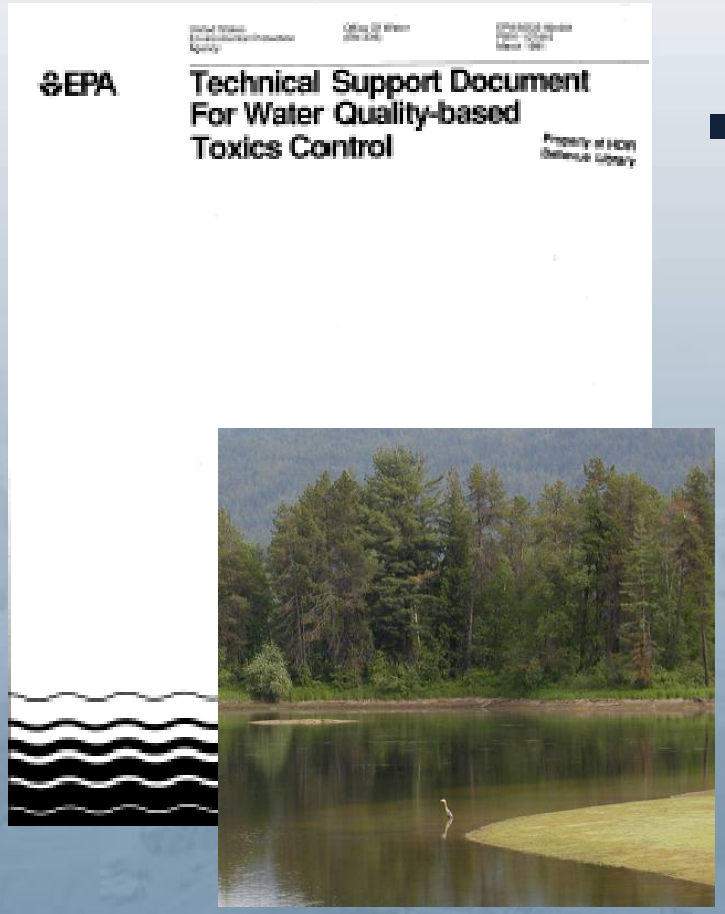
DEQ Alternative 4: Forward-calculated Water Quality Based Effluent Limits, Statistical Compliance Tools

- Use probabilistic effluent dilution model to estimate downstream concentrations associated with range of end-of-pipe effluent limits.
  - Distributions of estimated downstream predicted concentrations with each potential effluent limit evaluated with statistical compliance determination tools

- Show the Calculations
  - Critical Flow Assumptions
    - 7Q10 v. 30Q10 v. Other?
  - Ambient Water Quality
    - Coefficient of Variation and Extremes in Data Set
  - Effluent Water Quality
    - Assumed Coefficient of Variation
      - Variability in Low Nutrient Treatment Plants
  - Effluent Limits?
    - Monthly Average, Weekly, Daily Maximum?

EFFLUENT DISCHARGE PERMITTING ISSUES

Appropriate Discharge Permit Structure for Nutrients



- Translation Water Quality Criteria to NPDES to Permit Limits
  - Critical Interpretation of Water Quality Issues
    - Pre-formulated Permit Guidance from EPA and States Often Focused on Toxics

Nutrients Differ From Toxics

Nutrients

- No Immediate Impact
  - Aside from Ammonia
- Watershed Scale Impacts
  - Nutrient Enrichment Leads to Aquatic Growth
- Algal Response Over Longer Periods
  - Longer Averaging Period Appropriate for Nutrients
  - Seasonal or Annual Averages Appropriate
- Treatment Technology
  - Variability at Low Levels in the Best Technologies

Toxics

- Acute and Chronic Impacts on Aquatic Life
  - Chlorine, Metals, Organics
- Near-field (mixing zone) and Far-field (watershed) Impacts
- Long Term Response
  - Average Limits
- Short Term Response
  - Maximum Limits Required
- Treatment Technology
  - Available Technology to Prevent Excursions

Selection of Appropriate Critical Water Quality Conditions for Nutrients

- Default Selection of Extreme Late Summer Conditions and 7Q10 Flows Overly Restrictive
  - -Leads to In-Stream Standards Applied at End-of-Pipe
- Algal Response Over Longer Periods for Nuisance Conditions
  - -Longer Averaging Period Appropriate for Nutrients
  - -Seasonal or Annual Average Flows Appropriate
- Watershed Nutrient Loadings v. Effluent Mixing Zone Calculations

Clark Fork River, MT Voluntary Nutrient Reduction Program (VNRP) Selected 30Q10 Flow Condition

NPDES Permitting Regulations

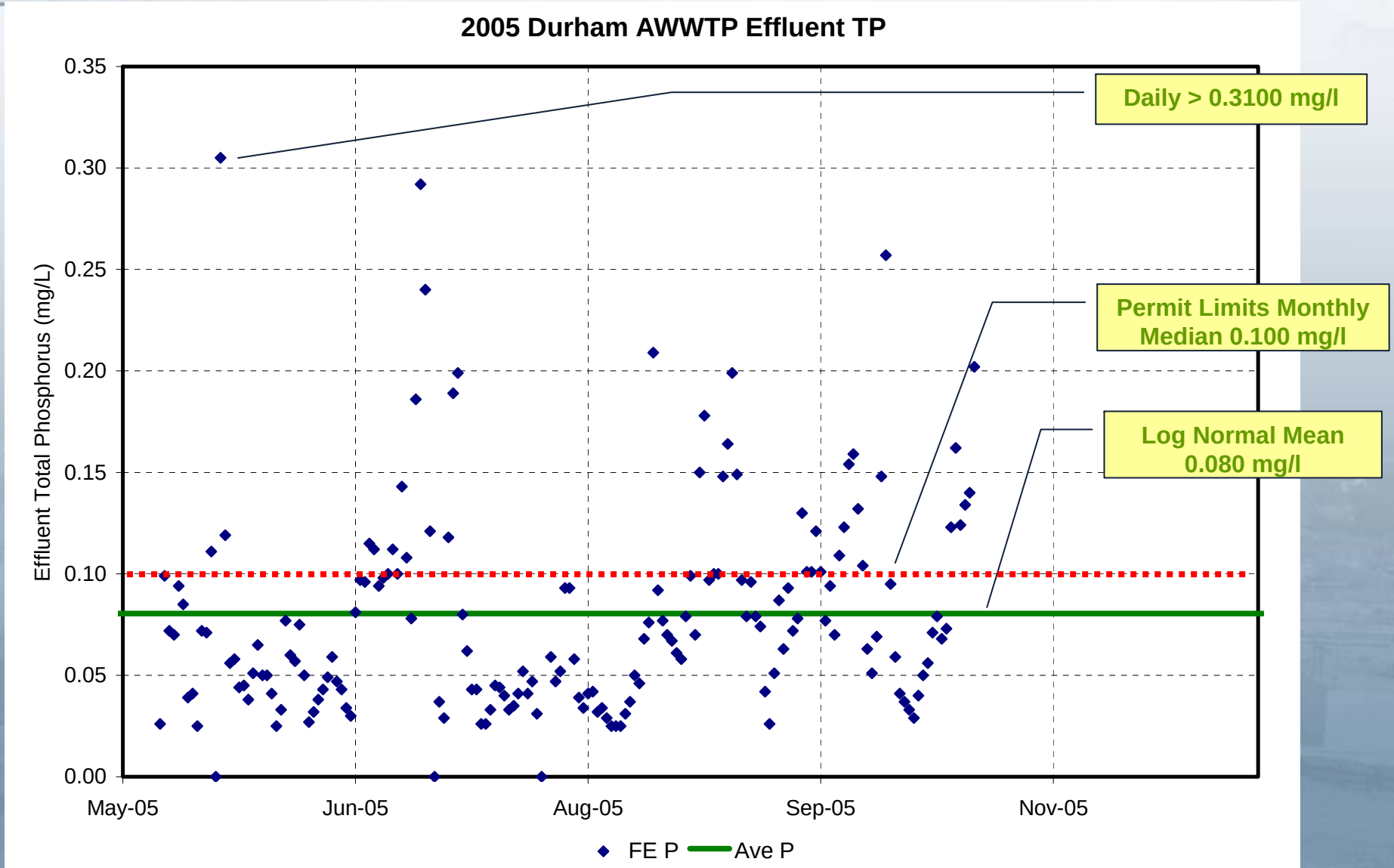
- 40 CFR 122.45(d) requires that all permit limits be expressed as average monthly limits and average weekly limits for publicly owned treatment works (POTWs) and as both average monthly limits and maximum daily limits for all others, unless "impracticable."

Maximum monthly, weekly, and daily limits likely to be exceeded by even the best designed and operated low nutrient treatment facilities

Effluent N and P concentration is highly variable for even the best designed and operated low nutrient treatment facilities

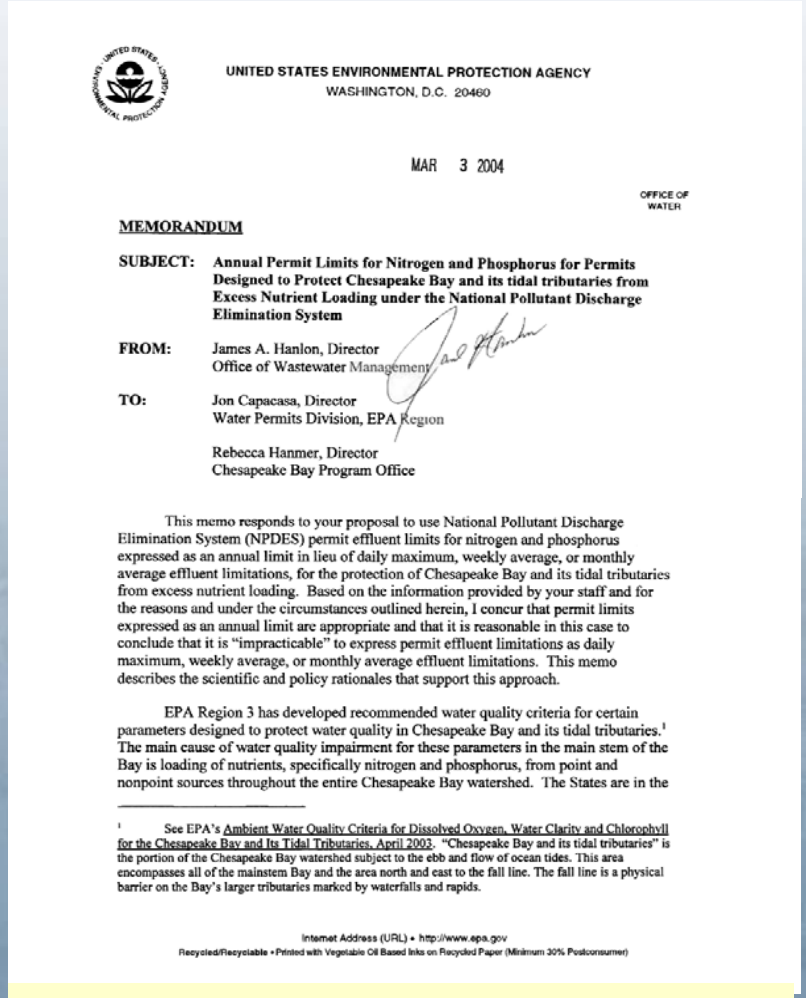
Individual permit writers in every nutrient limited watershed must interpret these NPDES regulations and the definition of "impracticable" with limited guidance

Effluent Performance Variability at Low Nutrient Levels in an Exemplary Facility



Daily Maximum, Weekly Average and Monthly Average Limits Not Mandatory

- Guidance from EPA Headquarters Office of Wastewater Management
- Annual Permit Limits for Nitrogen and Phosphorus for Permits Designed to Protect Chesapeake Bay
  - *"…permit limits expressed as an annual limit are appropriate and that it is reasonable in this case to conclude that it is "impracticable" to express permit effluent limits as daily maximum, weekly average, or monthly average effluent limitations."*



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 3 2004

OFFICE OF WATER

MEMORANDUM

SUBJECT: **Annual Permit Limits for Nitrogen and Phosphorus for Permits Designed to Protect Chesapeake Bay and its tidal tributaries from Excess Nutrient Loading under the National Pollutant Discharge Elimination System**

FROM: James A. Hanlon, Director
Office of Wastewater Management

TO: Jon Capacasa, Director
Water Permits Division, EPA Region

Rebecca Hanmer, Director
Chesapeake Bay Program Office

This memo responds to your proposal to use National Pollutant Discharge Elimination System (NPDES) permit effluent limits for nitrogen and phosphorus expressed as an annual limit in lieu of daily maximum, weekly average, or monthly average effluent limitations, for the protection of Chesapeake Bay and its tidal tributaries from excess nutrient loading. Based on the information provided by your staff and for the reasons and under the circumstances outlined herein, I concur that permit limits expressed as an annual limit are appropriate and that it is reasonable in this case to conclude that it is "impracticable" to express permit effluent limitations as daily maximum, weekly average, or monthly average effluent limitations. This memo describes the scientific and policy rationales that support this approach.

EPA Region 3 has developed recommended water quality criteria for certain parameters designed to protect water quality in Chesapeake Bay and its tidal tributaries.[1] The main cause of water quality impairment for these parameters in the main stem of the Bay is loading of nutrients, specifically nitrogen and phosphorus, from point and nonpoint sources throughout the entire Chesapeake Bay watershed. The States are in the

[1] See EPA's Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll for the Chesapeake Bay and Its Tidal Tributaries, April 2003. "Chesapeake Bay and its tidal tributaries" is the portion of the Chesapeake Bay watershed subject to the ebb and flow of ocean tides. This area encompasses all of the mainstem Bay and the area north and east to the fall line. The fall line is a physical barrier on the Bay's larger tributaries marked by waterfalls and rapids.

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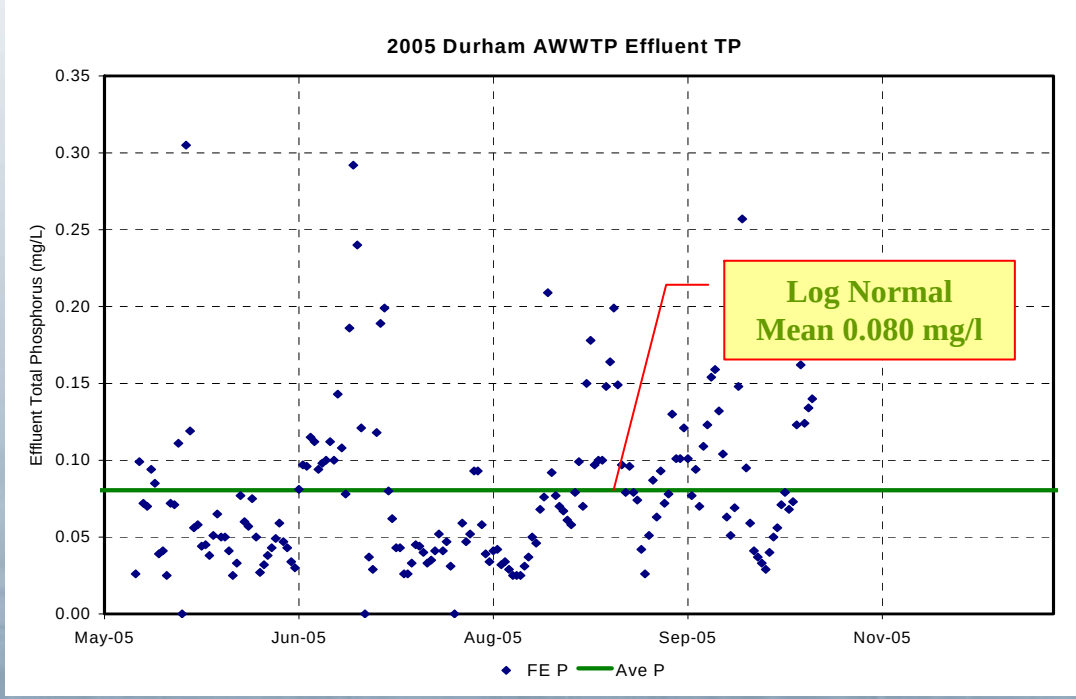
Jim Hanlon, Office of Wastewater Management, March 3, 2004

Recognition of Daily Treatment Process Variability at Very Low Nutrient Levels

- Daily Process Performance Varies Even in Excellent Treatment Plants
- Compliance Feasible
  - Median or Average Basis
  - Annual or Seasonal
- *Maximum Daily or Weekly Limits May Result in Noncompliance*



Clean Water Services of Washington County, OR (CWS)
Durham Plant Effluent Phosphorus, mg/l

Over specifying effluent discharge permit limits will not provide additional water quality protection

Kalispell MPDES Permit Limits September 2007

Parameter	Units	Average Monthly Limit (1)	Average Weekly Limit (1)	Maximum Daily Limit (1)
BOD_5	mg/L	10	15	--
	lb/day	259	388	--
TSS	mg/L	10	15	--
	lb/day	259	388	--
E. coli Bacteria, winter (2, 3)	cfu/100 mL	630	--	1260
E. coli Bacteria, summer (2, 3)	cfu/100 mL	126	--	252
Total Phosphorus as P	mg/L	1.0	--	--
	lb/day	25.8	--	--
Total Nitrogen (4)	lb/day	268	--	364
Total Ammonia as N	mg/L	--	--	2.22
Total Ammonia as N, winter (2)	mg/L	2.16	--	--
Total Ammonia as N, summer (2)	mg/L	1.23	--	--
Oil and Grease	mg/L	NA	NA	10
Dissolved Oxygen Saturation	%	--	--	>75%

Footnotes: NA means not applicable.
(1) See Definition section at end of permit for explanation of terms.
(2) Winter is November 1 through March 31; summer is April 1 through October 31.
(3) Report geometric mean if more than one sample is collected during the reporting period.
(4) Calculated as the sum of Nitrate + Nitrite as N and Total Kjeldahl Nitrogen concentrations.

Average Monthly Limits Concentration and Mass

Maximum Daily Limits

Missoula MPDES Permit August 2006

Effluent Limitations: Outfall 001				
Parameter	Units	Average Monthly Limit [1]	Average Weekly Limit [1]	Maximum Daily Limit [1]
Carbonaceous Biological Oxygen Demand ($cBOD_5$)	mg/L	19	30	NA
	lb/day	1,874	2,999	NA
Total Suspended Solids (TSS)	mg/L	23	34	NA
	lb/day	2,249	3,374	NA
E. coli [2, 3]	cfu./100 mL	126	252	NA
E. coli [3, 4]	cfu./100 mL	630	1,260	NA
Total Residual Chlorine	mg/L	0.011	NA	0.019
Total Nitrogen [5, 6]	lb/day	NA	NA	888.8
Total Phosphorus as P [6]	lb/day	NA	NA	88
Oil and Grease	mg/L	NA	NA	10

Footnotes:

1. See Definition section at end of permit for explanation of terms.
2. This limitation applies from April 1 through October 31.
3. Report Geometric Mean if more than one sample is collected in the reporting period.
4. This limitation applies from November 1 through March 31.
5. Calculated as the sum of Total Kjeldahl Nitrogen (TKN) and nitrate/nitrite as N concentrations.
6. This limitation applies from June 1 through September 30.

Maximum Daily Limits

City of Bozeman MPDES Permit Limits October 1, 2006

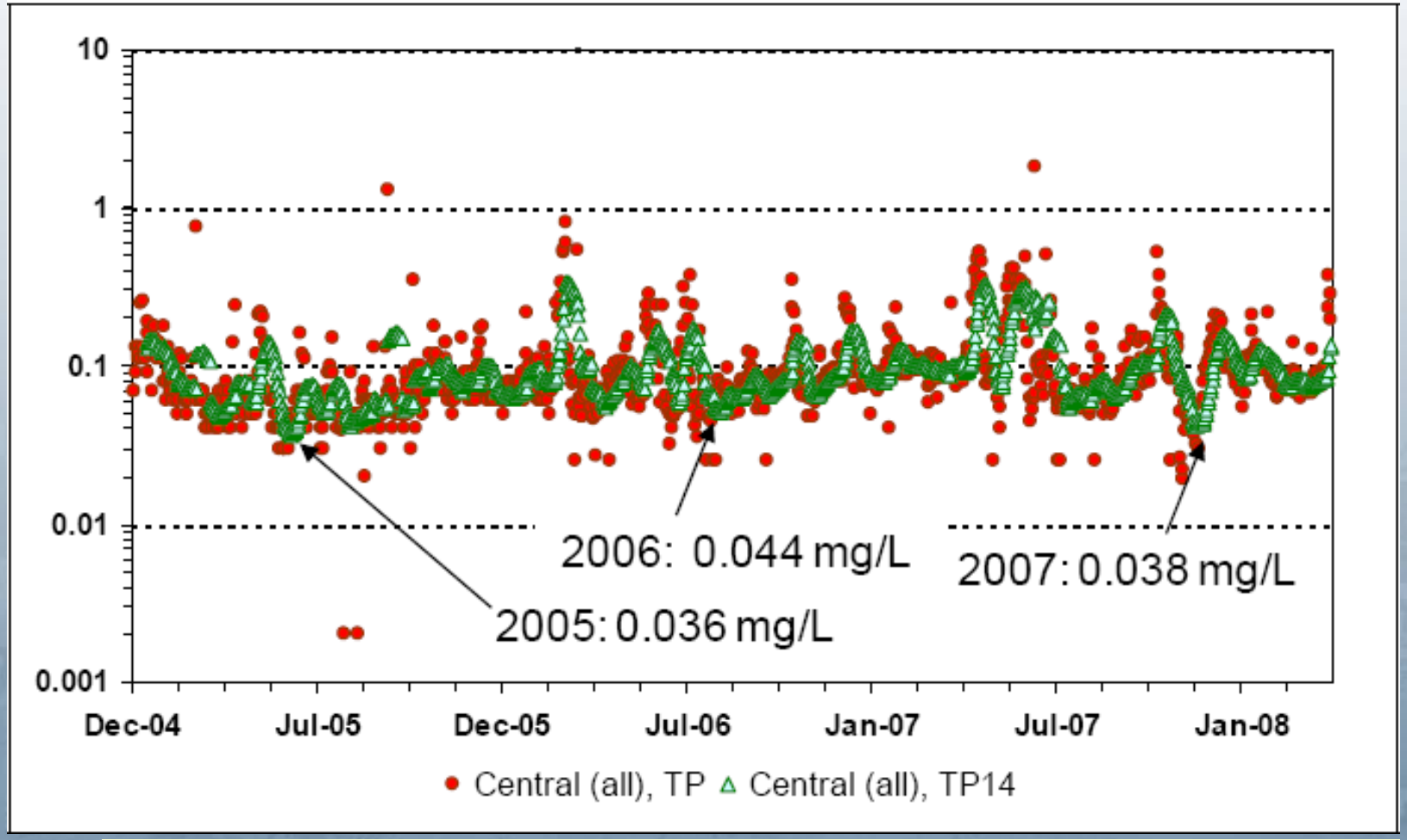
Effluent Limitations: Outfall 001				
Parameter	Units	Average Monthly Limit[1]	Average Weekly Limit[1]	Maximum Daily Limit[1]
Carbonaceous Biological Oxygen Demand (BOD_5)	mg/L	25	40	--
	lbs/day	1,072	1,928	--
Total Suspended Solids (TSS)	mg/L	30	45	--
	lbs/day	1,083	2,169	--
Escherichia coli Bacteria[2, 4]	No./100ml	126	--	252
Escherichia coli Bacteria[3, 4]	No./100ml	630	--	1,260
Total Residual Chlorine[5]	mg/L	--	--	0.011
Total Ammonia, as N	mg/L	1.52	--	3.15
Total Nitrogen	lbs/day[6]	783	--	971
	lbs/day[7]	864	--	1072
Total Phosphorus	lbs/day[6]	160	--	199
	lbs/day[7]	170	--	211

Footnotes:

1. See Definition section at end of permit for explanation of terms.
2. This limitation applies from April 1 through October 31.
3. This limitation applies from November 1 through March 31.
4. Report Geometric Mean if more than one sample is collected in the reporting period.
5. The Permittee will be in compliance with the applicable effluent limitation if the total residual chlorine does not exceed the minimal level (ML) of 0.1 mg/L.
6. Effective during the growing season June 1 through September 30. Limits affective June 1, 2007.
7. Effective during the nongrowing season October 1 through May 31. Limits affective October 1, 2007.

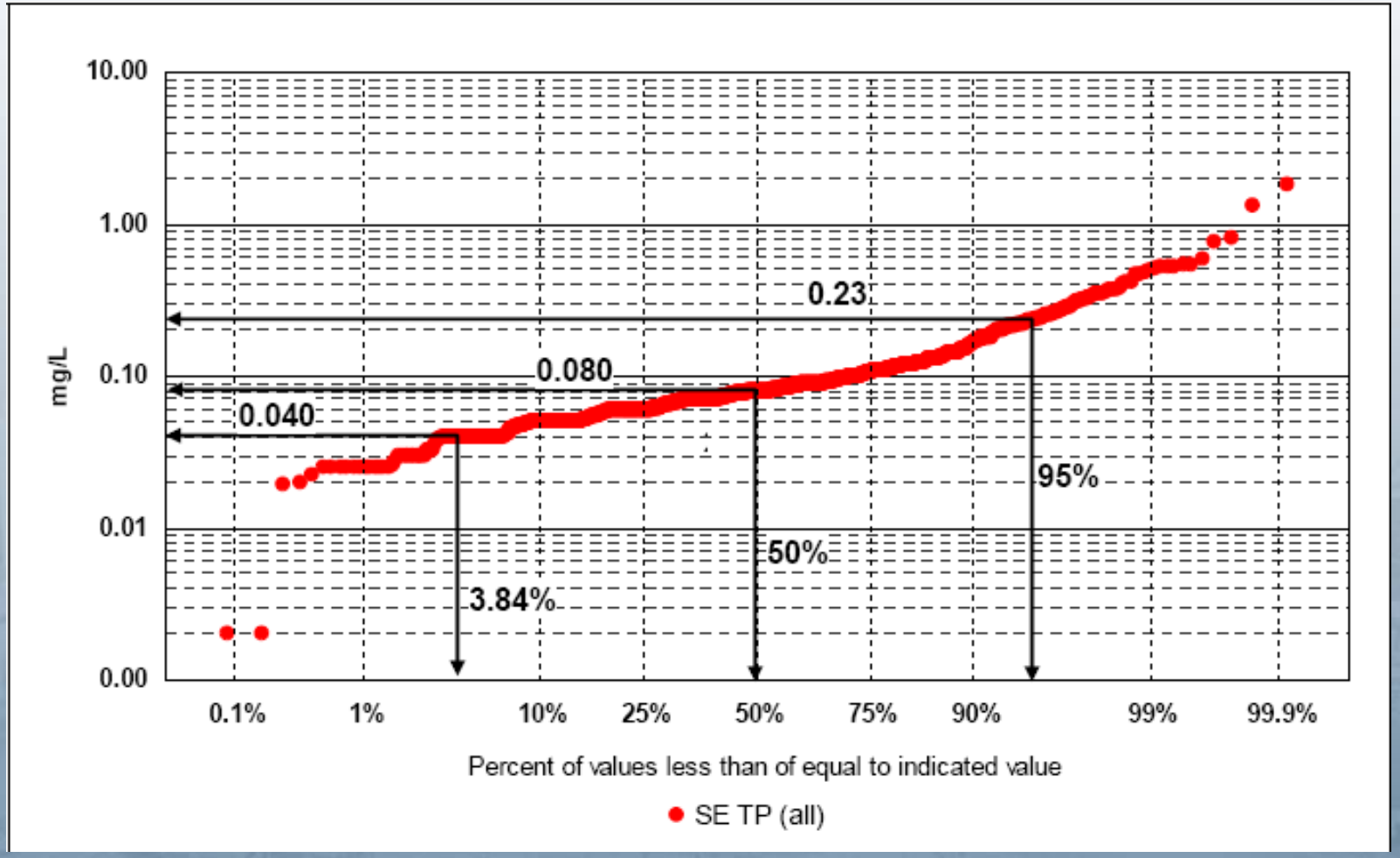
Maximum Daily Limits

Daily Data from Plant Striving to Achieve 0.1 mg/L Effluent Total Phosphorus



Excerpt from "What is the Limit of Technology (LOT)? A Rational and Quantitative Approach," JB Neethling, D. Stensel, C. Bott, D. Parker, S. Murthy, A. Pramanik, and D. Clark, June 2009.

Probability Scale Plot of Effluent P Data Showing 3.84th, 50th, and 95th Percentiles



Excerpt from "What is the Limit of Technology (LOT)? A Rational and Quantitative Approach," JB Neethling, D. Stensel, C. Bott, D. Parker, S. Murthy, A. Pramanik, and D. Clark, June 2009.

Treatment Performance Statistics

- Performance Achieved by a Technology Under Specific Conditions and Expressed in Statistical Terms
  - Lowest Technology Can Achieve
    - Lower 14-day per Year Performance (3.84th percentile)
  - Full Scale Plant Performance
    - Lower 14-day Performance Typically 40% to 50% Median (50th Percentile)
    - 95th Percentile Typically 200% to 300% of Median

Excerpt from "What is the Limit of Technology (LOT)? A Rational and Quantitative Approach," JB Neethling, D. Stensel, C. Bott, D. Parker, S. Murthy, A. Pramanik, and D. Clark, June 2009.

Summary Total Phosphorus Treatment Performance Statistics

Table 5 – Total Phosphorus TAL Concentration From Plants[a]

	Process	Permit [c]	14 d	50%	95%	14 d/50%	95%/50%
Rock Creek	2B	0.1	0.025	0.065	0.210	0.38	3.2
Gwinnett County	1B	0.13 (0.08)	0.020	0.040	0.110	0.50	2.8
DCWASA	2	0.18	0.020	0.080	0.180	0.25	2.3
CCWRD-Central Plant	2B	0.14	0.040	0.080	0.233	0.50	2.9
CCWRD-AWT	2B	0.14	0.040	0.082	0.176	0.49	2.1
Cauley Creek	1B	0.13	0.040	0.080	0.160	0.50	2.0
WSSC	1	1	0.050	0.140	0.650	0.36	4.6
Eastern EWRF Orange Co	1B	2	0.100	0.190	0.630	0.53	3.3
Breckenridge	2B	0.050	0.004	0.012	0.045	0.33	3.8

Note:

a. Plant data presented at Workshop 101, WEFTEC08 conference, Chicago, IL

b. Process: 1=Single stage chemical addition; 2=Multistage chemical addition; B= Biological phosphorus removal

c. Permit limits are shows only as an indication of the requirement under which the plant operates. Permits requirements varies – for example Rock Creek operates under a monthly median permit; DCWASA operates under an annual limit

Excerpt from "What is the Limit of Technology (LOT)? A Rational and Quantitative Approach," JB Neethling, D. Stensel, C. Bott, D. Parker, S. Murthy, A. Pramanik, and D. Clark, June 2009.

EXAMPLE DISCHARGE PERMITS FOR NUTRIENTS

Variety of Permit Structures Nationally for Nutrients

- Concentration Only, Mass Only, Both
  - Seasonal Limits
  - Mean or Median
  - Shared Capacity

Location	Total Phosphorus Limits	Comments
Clean Water Services of Washington County, OR	0.100 mg/l	Monthly Median, May 1 to Oct 31 Watershed Permit
Las Vegas, Clark County, Henderson, NV	334 lbs/day (130/174/30 lbs/day)	Mar 1 to Oct 31 Cooperative Agreement to Share for Flexibility
Alexandria, VA	0.18 mg/l and 37 kg/day 0.27 mg/l and 55 kg/day	Monthly Average Weekly Average

Clean Water Services of Washington County, OR Tualatin River

(2) **Phosphorus**

The phosphorus reduction period begins May 1 and ends October 31.

Outfall Number	Parameter	Monthly Median Effluent Concentration
D001	Total Phosphorus	0.11 mg/L
R001	Total Phosphorus	0.10 mg/L

Four individual permits for the operation of publicly owned sewage treatment works (POTWs), one municipal separate storm sewage system (MS4) permit and individual storm water permits for the Durham and Rock Creek Advanced Wastewater Treatment Facilities in the Tualatin River watershed have been integrated and consolidated into this document. This represents a change in the traditional approach to regulatory management of the watershed by integrating several program elements of the Clean Water Act into a single document along with water quality trading. This combination allows 1) greater coordination of watershed protection and enhancement programs, 2) greater coordination of watershed assessment and monitoring activities, and 3) greater public involvement.

- Monthly Median Limits
- Concentration Only
- Seasonal
- **Shared Wasteload Allocation**

City of Las Vegas, NV Las Vegas Wash

Table I.3

Constituent	City of Las Vegas IWLA	Clark County Sanitation District IWLA	City of Henderson IWLA	ΣWLA
Total Phosphorus as P	130 lb/day	174 lb/day	30 lb/day	334 lb/day, Note: This WLA only applies March 1 - October 31; no limit applies the rest of the year.
Total Ammonia as N	379 lb/day	502 lb/day	89 lb/day	970 lb/day, Note: This WLA only applies April 1 - September 30; no limit applies the rest of the year.

I.A.2. **Waste Load Allocation (WLA)** The Permittee is authorized to discharge the waste loads listed in Table I.3. for Total Phosphorus as P and Total Ammonia as N, to the Las Vegas Wash. The WLA applies to the combined loading from Outfalls 001 and 002. This permit condition constitutes a cooperative agreement between the City of Las Vegas, Clark County Sanitation District, and City of Henderson (hereinafter dischargers) to allow discharge flexibility. Each facility has an **Individual Waste Load Allocation (IWLA)** and there is a **Sum of Waste Load Allocations (ΣWLA)** defined below for the three facilities. Treatment facilities which are used to attain a waste load allocation are not required to be operated when not needed to meet that allocation.

a. The Permittee shall be considered in compliance if **either**:

i. The Permittee does not exceed the **IWLA** listed below or the **IWLA** in effect due to transfers, **or**

ii. The **Sum of the Waste Load Allocations (ΣWLA)** listed below is not exceeded.

- Mass Only
- Seasonal
- Shared Wasteload Allocation

Alexandria, VA Hunting Creek/Hooff Run, Potomac River

A.1. Effluent Limitations and Monitoring Requirements

1. Outfall 001–54 MGD Design Flow

a. There shall be no discharge of floating solids or visible foam in other than trace amounts.

b. During the period beginning with the permit's effective date and lasting until the permit's expiration date, the permittee is authorized to discharge from Outfall Number 001. Such discharges shall be limited and monitored by the permittee as specified below.

PARAMETER	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
	Monthly Average[1]	Weekly Average[1]	Minimum	Maximum[1]	Frequency	Sample Type
Flow[2] (MGD)	NL	N/A	N/A	NL	Continuous	TIRE
$cBOD_5$[5]	5 mg/l 1022 kg/day	8 mg/l 1635 kg/day	N/A	N/A	1/D	24HC
TSS	6.0 mg/l 1226 kg/day	9.0 mg/l 1840 kg/day	N/A	N/A	1/D	24HC
TKN	NL	NL	N/A	N/A	1/W	24HC
Ammonia as Nitrogen (Apr-Oct)	1.0 mg/l 204 kg/day	4.4 mg/l 899 kg/day	N/A	N/A	1/D	24HC
Ammonia as Nitrogen (Nov-January)	8.4 mg/l	10.4 mg/l	N/A	N/A	1/D	24HC
Ammonia as Nitrogen (February-March)	7.4 mg/l	9.1 mg/l	N/A	N/A	1/D	24 HC
Nitrate as Nitrogen	NL	NL	N/A	N/A	1/W	24 HC
Nitrite as Nitrogen	NL	NL	N/A	N/A	1/W	24 HC
Total Nitrogen	NL	NL	N/A	N/A	1/W	24 HC
Total Phosphorous	0.18 mg/l 37 kg/day	0.27 mg/l 55 kg/day	N/A	N/A	1/D	24HC
Orthophosphorous	NL	NL	N/A	N/A	1/W	24 HC

- Monthly Average and Weekly Average Limits
- Concentration and Mass

Truckee Meadows Water Reclamation Facility, NV Truckee River

PARAMETERS	EFFLUENT DISCHARGE LIMITATIONS						MONITORING REQUIREMENTS		
	30-Day Average			Daily Maximum			Sample Location[13]	Measurement Frequency	Sample Type
	mg/L	Kg/day	lb/day	mg/L	Kg/day	lb/day			
Dissolved Organic Nitrogen –N (mg/L)	Monitor and Report[12]						i.	Weekly	Composite
Total Phosphorus –P	0.40	61[3]	134[3]	—	---	---	i.	Daily	Composite
Total Phosphates –P (filtered) (mg/L)	Monitor and Report						i.	Weekly	Composite
Dissolved Organic	Monitor and Report								

- Monthly Average
- Concentration and Mass

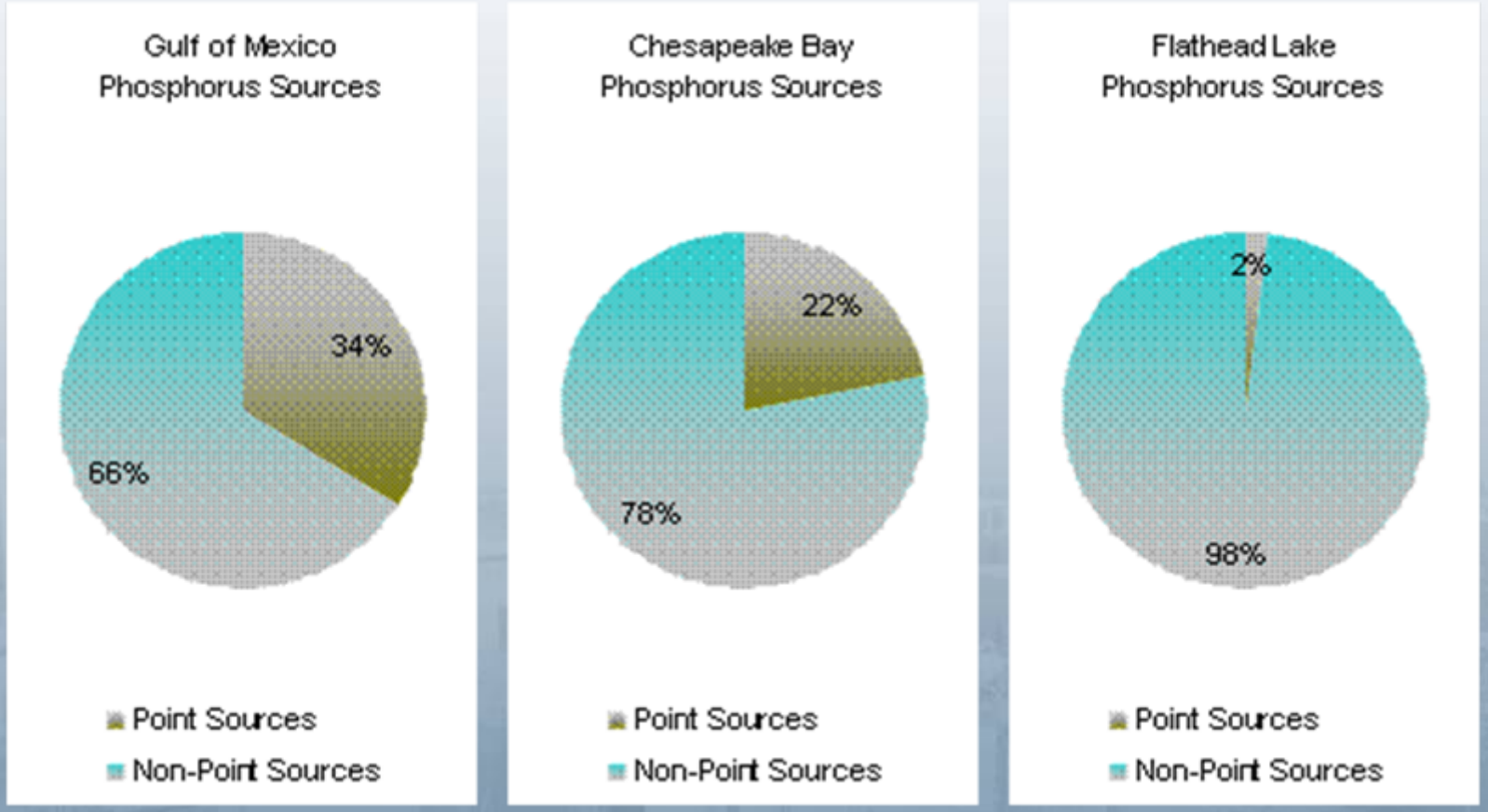
ISSUES FOR NEXT MEETING

Comparison of Point and Nonpoint Source Nutrient Control Performance

Approach	Nutrient Removal Performance	Cost Effectiveness
Point Source	80% to 90%	$0.50 to $50+ $/lb
Advanced Treatment		
Nonpoint Source	15% to 80%	$0.50 to $300+ $/lb
Best Management Practices[1]		

[1]Conservation Tillage, Grass Buffers, Detention Basins, Wetlands

Nonpoint Sources Dominate Many Watersheds



Phosphorus Loading Summaries for Gulf of Mexico, Chesapeake Bay, and Flathead Lake

Sustainability Comparison of Point and Nonpoint Source Nutrient Controls

Approach	Electrical Power	Chemical Use	Greenhouse Gas	Additional Watershed Enhancements
Point Source Advanced Treatment	+50% to + 250% over Secondary Treatment	Alum, Ferric, Methanol, other carbon sources	+120% over Secondary Treatment	None
Nonpoint Source Best Management Practices[1]	None	None	Sequesters Carbon	Enhanced Habitat, Aesthetics, Sediment Reduction

[1]Conservation Tillage, Grass Buffers, Detention Basins, Wetlands

Conditions Required for Potential Water Quality Offsets or Trading

- "Driver" for Pollutant Reductions
  - TMDL
  - NPDES Permit
    - Permit Limits Conducive to Trading
- Sources with Significantly Different Costs for Control
- Pollutant Reduction Not So Large That All Sources Must Reduce as Much as Possible
  - Need a Surplus of Reductions To Trade
- Willing Stakeholders and Agencies
- Loading Analysis
  - Point Sources Defined
  - Need to Quantify Nonpoint Source Loadings

Conventional Tillage

Conservation Tillage